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None

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## (54) Self defence system against missiles

(57) The invention relates to a self-defence system for aircraft against missiles, and provides a combination of a proximity sensor for the enemy missile, an intercept rocket and a directed light beam, wherein selectively the light beam is used alone as optical jammer against an optical target seeker head of the missile, or together with the intercept rocket for its optical guidance either according to the semi-active guidance procedure or according to the beam-carrier guidance procedure.

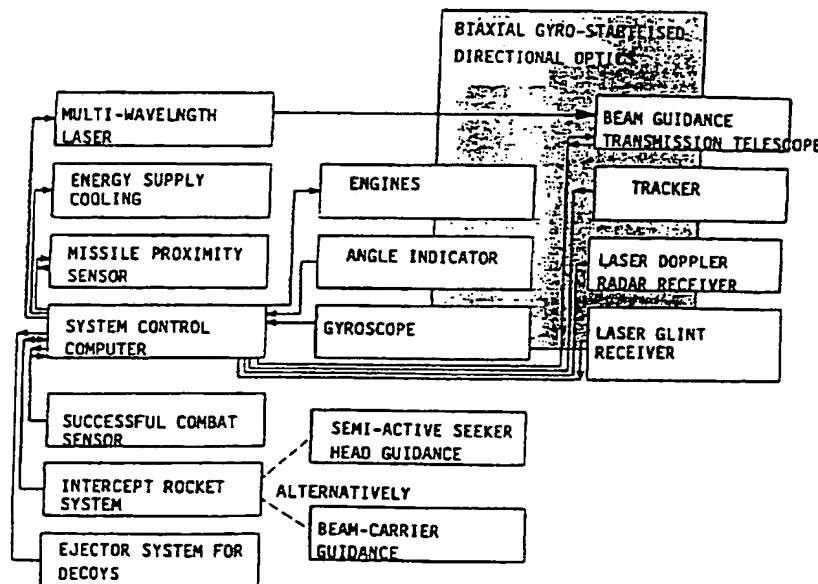


FIG. 1

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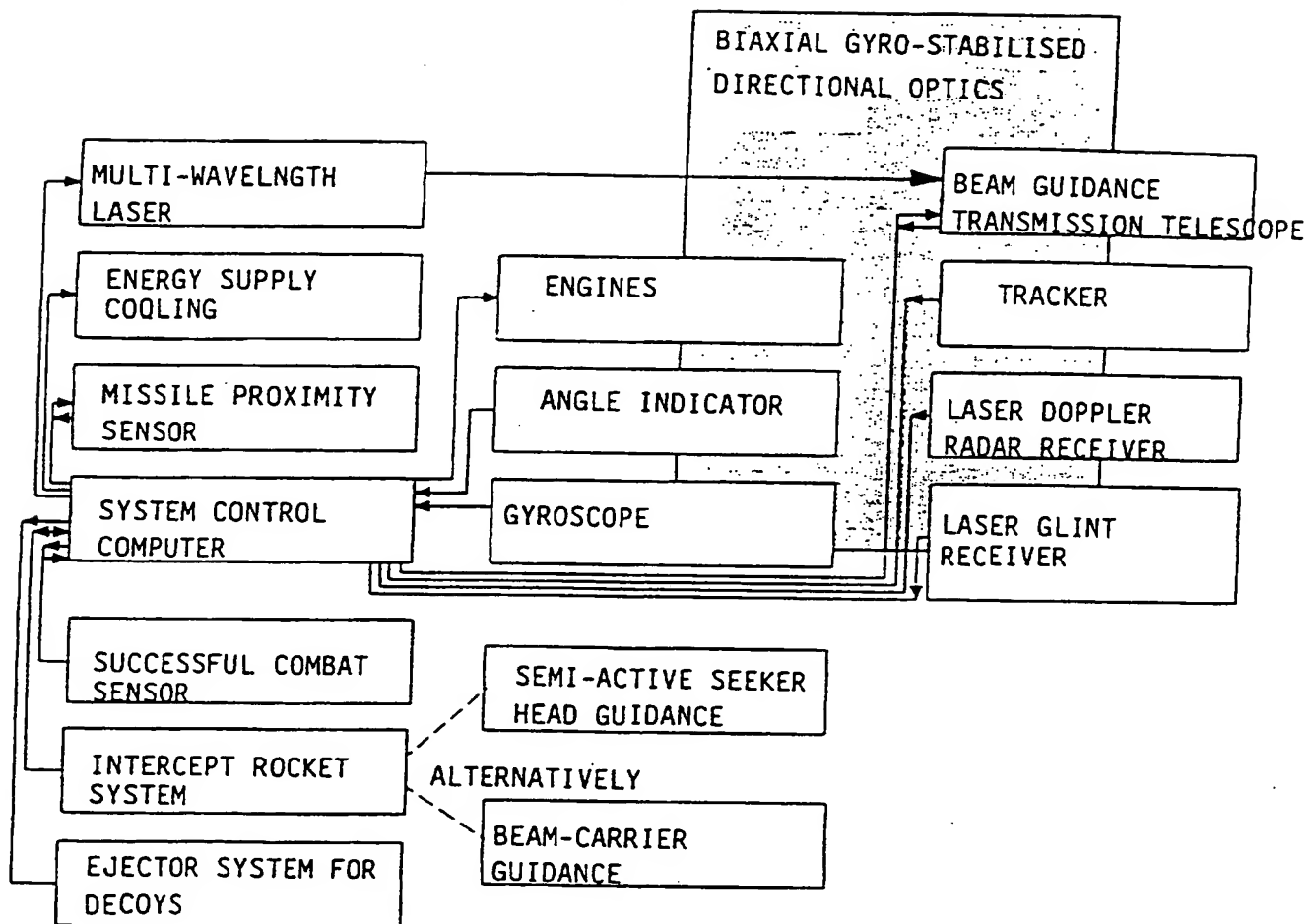


FIG. 1

**SELF-DEFENCE SYSTEM AGAINST MISSILES**

5 The invention relates to a self-defence system against  
missiles preferably for aircraft against missiles, with  
a proximity sensor for enemy missiles and an intercept  
rocket system dependent thereon with a control  
computer.

10 Such a system, comprising an electronic control unit,  
an "IR jammer head" and an electro-optical missile  
sensor, has become known from the publication "Aviation  
Week & Space Technology", March 28, 1994, pages 57-60.  
The gimbal mounted "IR jammer head" is provided with  
15 three apertures, the largest of which is for a xenon  
arc lamp, the medium aperture contains the optical  
elements for the array sensor in the missile tracker  
and the smallest aperture is allocated to the laser  
optics.

20

This system cannot be used against missiles with no  
optical seeker head, and can only be used to a limited

extent against missiles with modern infrared seeker heads.

5 Missiles with optical seeker heads can be combatted both with jamming lasers and with intercept rockets. However, the use of intercept rockets in this case is very uneconomical. Missiles with no optical seeker heads can, however, be combatted virtually solely with intercept rockets.

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The object of the present invention is to provide a system of the aforementioned type, which assures reliable, secure and more economical self-defence preferably against missiles of all the types specified.

15

In a first aspect, the present invention provides a self-defence system, preferably for aircraft against missiles, with a proximity sensor for enemy missiles and an intercept rocket system dependent thereon with a control computer, wherein the system has an optical jamming and guidance system equipped with a light source and directional optics which is dependent on the

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proximity sensor and is capable of emitting a light beam in a specific direction, this direction being calculable by a control computer of the jamming and guidance system in dependence on the flight path of the missile, the control computer is capable of calculating whether the missile should be fought by optical jamming or by an intercept rocket, and whether this direction is accordingly either the direction towards the tip of the missile or towards a point of high vulnerability of the missile or towards the collision point of the intercept rocket with the missile, and whether the wavelength and modulation of the light beam is either optimised with respect to the jamming capacity of an optical target seeker head of the missile or to a semi-active guidance procedure or to a beam-carrier guidance procedure for the intercept rocket and the control computer is capable of calculating whether an intercept rocket equipped for the semi-active guidance procedure or for the beam-carrier guidance procedure is fired.

The sub-claims specify configurations and further developments.

Preferably the specific direction of the light beam is calculable in dependence on the flight paths of both the aircraft (when the system is mounted in an aircraft) and the incoming missile.

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In a second aspect, the present invention provides a method of operating a self-defence system, preferably for aircraft against missiles, with a proximity sensor for enemy missiles and an intercept rocket system dependent thereon with a control computer, the method including the steps of wherein the system has an optical jamming and guidance system equipped with a light source and directional optics which is dependent on the proximity sensor and emits a light beam into a specific direction, calculating this direction by a control computer of the jamming and guidance system in dependence on the flight path of the missile, using the control computer to decide whether the missile should be fought by optical jamming or by an intercept rocket, and whether this direction is accordingly either the direction towards the tip of the missile or towards a point of high vulnerability of the missile or towards

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the collision point of the intercept rocket with the missile, and whether the wavelength and modulation of the light beam is either optimised with respect to the jamming capacity of an optical target seeker head of the missile or to a semi-active guidance procedure or to a beam-carrier guidance procedure for the intercept rocket and using the control computer to decide whether an intercept rocket equipped for the semi-active guidance procedure or for the beam-carrier guidance procedure is fired.

The following description explains practical embodiments of the present invention shown in a block diagram (Fig. 1). This block diagram shows the structure and function of the described practical example.

The general concept of the invention envisages a combination of a proximity sensor for the enemy missile, an intercept rocket and a directed light beam, wherein selectively the light beam is used alone as optical jammer against an optical seeker head of the

missile, or is used together with the intercept rocket to guide it optically either by means of the semi-active or by the beam-carrier guidance procedure. The system assemblies necessary for this are shown so clearly in the drawing that detailed information should be unnecessary for one skilled in the art.

A control computer of the system firstly decides whether the enemy missile detected by the proximity sensor should be fought by optical jamming or by an intercept rocket. Prior information as to the probability of the enemy missile being fitted with an optical seeker head is taken into account in this case. If the decision is for optical jamming, the control computer calculates the direction towards the tip of the missile where its optical seeker head will be located, accordingly lines up biaxially stabilised directional optics, for example, and irradiates the seeker head of the enemy missile with a light beam optimised with respect to optical jamming. As a result, the missile loses its target, which means that a hit is generally prevented.



In order to assure effective optical jamming of the seeker head, the light beam encompasses wavelengths within at least one of the wavelength ranges relevant for the optical seeker heads. The light source used is preferably a laser, formed by a diode-pumped solid-state laser with an opto-parametric oscillator and which emits a laser beam preferably with several wavelengths in the ranges 0.7 - 1.2  $\mu\text{m}$  and 3 - 5  $\mu\text{m}$ .

In addition, the optical jamming system is provided with a tracker, which measures and analyses the backscatter of light from the marked missile with a laser glint receiver and inputs the resulting measured signals into the system control computer, which itself controls the directional optical system for the laser beam, so that it is directed onto the tip, i.e. the point on the missile where an optical seeker is assumed to be located, and is held there.

A so-called successful combat sensor is connected to the system control computer which, by analysing the signals of the missile proximity sensor, the tracker

and an inertial sensor allocated to the aircraft,  
ascertains whether the approach path of the attacking  
missile has been sufficiently jammed. If this is the  
case within an adequate safety margin, then the combat  
5 procedure is terminated.

However, if this is not the case, then the control  
computer decides to combat the enemy missile with an  
intercept rocket which is guided optically either by a  
10 semi-active guidance procedure or by a beam-carrier  
guidance procedure. In accordance with this, the  
control computer calculates the direction either to a  
point of high vulnerability of the missile or to the  
collision point of the intercept rocket with the  
15 missile. The control computer also determines whether  
the wavelength and modulation of the light beam is  
optimised and adjusted either with respect to the semi-  
active guidance procedure or the beam-carrier guidance  
procedure, and whether an appropriately equipped  
20 intercept rocket is fired. In the case of optimisation  
of the light beam, either the laser light generated by  
the solid-state laser or the laser light generated by

the laser diodes is preferably used.

The guidance procedure working with directed light is preferably a semi-active guidance procedure, in which  
5 case the laser beam is closely bundled and is directed by the tracker onto the respectively most favourable point on the attacking missile, and is held there, and the intercept rocket is provided with a corresponding seeker head for this. The seeker head is preferably  
10 directed towards the attacking missile prior to the intercept rocket being fired. If it has detected the backscatter of light there, then the intercept rocket is fired.

15 The guidance procedure working with directed light can also be a so-called beam-carrier guidance procedure, in which case the tracker modulates the fanned light beam accordingly and guides it onto the most favourable point of the envisaged collision point with the  
20 attacking missile. The intercept rocket is therefore equipped with a rear receiver working in the appropriate wavelength range, the signals from which

are evaluated with the guidance computer for alignment with the collision point with the attacking missile.

The optical jamming system may be constructed so that  
5 the laser, directional optics and tracker form a laser doppler radar system, which measures the velocity of the attacking missile and inputs the successful combat sensor as the result. However, the laser, directional optics and tracker may also form a laser range-finder,  
10 the measured signals of which are input to the successful combat sensor.

The combat sensor now compares the values measured continuously during optical jamming: relating to radial  
15 velocity and distance of the missile as well as the direction to the missile, calculates the envisaged flight path of the missile therefrom, and compares this with the flight path determined at the beginning of optical jamming. If these two flight paths differ  
20 sufficiently from one another so that no hit is expected to occur, then this is evaluated as a successful combat. Any further attacking missile can

now be fought.

A further development provides that the proposed self-defence system is equipped with an ejector for optical decoys, in which case, on determination of the flight path of the attacking missile established by the missile proximity sensor, tracker and successful combat sensor, the system control computer selects whether the optical jamming system, decoys or intercept rocket, or a combination thereof, should be used and activated. A sensor sensitive in the UV wavelength range may be used as missile proximity sensor both in this case and as a general rule.

This type of sensor recognises the approaching enemy missile by the UV emission from its exhaust trail.

The intercept rocket working with the semi-active guidance procedure may, for example, be equipped with a single seeker head arranged symmetrically to its axis and comprising several detector elements and a receiver lens with an interference filter adapted to the laser

wavelength connected in front of it. The backscatter of  
laser light from the attacking missile is easily  
defocussed onto the detector elements, in which case  
the detector electronics assembly analyses the received  
5 intensities and from this calculates the direction of  
incidence of the backscatter of laser light and inputs  
it to the guidance computer.

This semi-active guidance procedure for the intercept  
10 rocket can, for example, work according to the so-  
called "dog curve procedure" and without an inertial  
system, or may also work according to the so-called  
"proportional navigation procedure" and with an  
inertial system in the intercept rocket.

**Patent Claims:**

1. Self-defence system, preferably for aircraft  
5 against missiles, with a proximity sensor for  
enemy missiles and an intercept rocket system  
dependent thereon with a control computer,  
wherein:

10 a) the system has an optical jamming and  
guidance system equipped with a light source  
and directional optics which is dependent on  
the proximity sensor and is capable of  
emitting a light beam in a specific  
15 direction, this direction being calculable  
by a control computer of the jamming and  
guidance system in dependence on the flight  
path of the missile;

20 b) the control computer is capable of  
calculating whether the missile should be  
fought by optical jamming or by an intercept

rocket, and whether this direction is accordingly either the direction towards the tip of the missile or towards a point of high vulnerability of the missile or towards the collision point of the intercept rocket with the missile, and whether the wavelength and modulation of the light beam is either optimised with respect to the jamming capacity of an optical target seeker head of the missile or to a semi-active guidance procedure or to a beam-carrier guidance procedure for the intercept rocket; and

c) the control computer is capable of calculating whether an intercept rocket equipped for the semi-active guidance procedure or for the beam-carrier guidance procedure is fired.

2. System according to Claim 1, wherein the seeker head of the intercept rocket equipped for the semi-active guidance procedure is directable



towards the missile prior to the missile being fired, and that the system is adapted to fire only when the seeker head has detected the backscatter of light from the missile.

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3. System according to Claim 1 or 2, wherein the light beam encompasses wavelengths within at least one of the wavelength ranges relevant for optical seeker heads.

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4. System according to Claims 1 to 3, wherein the light beam is generated by at least one laser.

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5. System according to Claims 1 to 4, wherein the optical jamming and guidance system has a tracker, which is usable to measure the backscatter of light from the missile with a receiver, analyse it and pass it to the control computer, whereupon the latter is operable to control the directional optics in such a way that the light beam is held on the selected point on the missile.

20

6. System according to Claims 1 to 5, wherein

5 a) the system has a "successful combat"  
sensor connected to the control computer  
which, when the missile is optically jammed,  
is usable to establish whether the approach  
path of the missile has been jammed  
sufficiently by the light beam by analysing  
10 the signals of the proximity sensor, tracker  
and an inertial sensor allocated to the  
aircraft; and

15 b) if the combat has not been successful,  
the control computer is operable to switch  
the system over from optical jamming to  
combat with an intercept rocket.

7. System according to Claims 1 to 6, wherein

20 a) the light source has a laser formed by  
a diode-pumped solid-state laser with an

opto-parametric oscillator and which emits a laser beam preferably with at least one wavelength in the ranges 0.7 - 1.2  $\mu\text{m}$  and 3 - 5  $\mu\text{m}$ , and

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b) on switchover to combat with an intercept rocket, the laser is modified so that either the laser light generated by the solid-state laser or that generated directly from the laser diodes is emitted.

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8. System according to Claim 7, wherein

a) the optical jamming system is constructed so that the laser, directional optics and tracker at the same time or alternately form a laser doppler radar system, which measures the velocity of the missile, and

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b) the signals of the doppler radar system are passed to the successful combat sensor.

9. System according to Claim 7 or 8, wherein

5 a) the optical jamming system is constructed so that the laser, directional optics and tracker at the same time form a laser range-finder, which measures the distance of the missile, and

10 b) the signals of the laser range-finder are passed to the successful combat sensor.

10. System according to Claim 9, wherein

15 a) the self-defence system is equipped with an ejector for optical decoys;

20 b) on determination of the flight path of the attacking missile established by the missile proximity sensor, tracker and successful combat sensor, the control computer selects and optimises the use of

the optical jamming system, decoys and intercept rockets.

11. System according to Claim 9 or 10, wherein the  
5 missile proximity sensor is a sensor sensitive in  
the UV wavelength range.

12. A missile self-defence system substantially as  
any one embodiment herein described with  
10 reference to the accompanying drawings.

13. A method of operating a self-defence system,  
preferably for aircraft against missiles, with a  
proximity sensor for enemy missiles and an  
15 intercept rocket system dependent thereon with a  
control computer, the method including the steps  
of:

a) wherein the system has an optical  
20 jamming and guidance system equipped with a  
light source and directional optics which is  
dependent on the proximity sensor and emits

a light beam into a specific direction,  
calculating this direction by a control  
computer of the jamming and guidance system  
in dependence on the flight path of the  
missile;

b) using the control computer to decide  
whether the missile should be fought by  
optical jamming or by an intercept rocket,  
and whether this direction is accordingly  
either the direction towards the tip of the  
missile or towards a point of high  
vulnerability of the missile or towards the  
collision point of the intercept rocket with  
the missile, and whether the wavelength and  
modulation of the light beam is either  
optimised with respect to the jamming  
capacity of an optical target seeker head of  
the missile or to a semi-active guidance  
procedure or to a beam-carrier guidance  
procedure for the intercept rocket; and

c) using the control computer to decide whether an intercept rocket equipped for the semi-active guidance procedure or for the beam-carrier guidance procedure is fired.

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14. A method according to Claim 13, wherein the seeker head of the intercept rocket equipped for the semi-active guidance procedure is directed  
10 towards the missile prior to the missile being fired, and firing only occurs when the seeker head has detected the backscatter of light from the missile.

15 15. A method according to Claim 13 or 14, wherein the light beam encompasses wavelengths within at least one of the wavelength ranges relevant for optical seeker heads.

20 16. A method according to Claims 13 to 15, wherein the light beam is generated by at least one laser.

17. A method according to Claims 13 to 16, wherein the optical jamming and guidance system has a tracker, which measures the backscatter of light from the missile with a receiver, analyses it and passes it to the control computer, whereupon the latter controls the directional optics in such a way that the light beam is held on the selected point on the missile.

18. A method according to any one of Claims 13 to 17, wherein

a) the system has a successful combat sensor connected to the control computer which, when the missile is optically jammed, establishes whether the approach path of the missile has been jammed sufficiently by the light beam by analysing the signals of the proximity sensor, tracker and an inertial sensor allocated to the aircraft;

b) that if the combat has not been



over from optical jamming to combat with an intercept rocket.

19. A method according to Claims 13 to 18, wherein

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a) the light source has a laser formed by a diode-pumped solid-state laser with an opto-parametric oscillator and which emits a laser beam preferably with at least one  
10 wavelength in the ranges 0.7 - 1.2  $\mu\text{m}$  and 3 - 5  $\mu\text{m}$ , and

b) on switchover to combat with an intercept rocket, the laser is modified so  
15 that either the laser light generated by the solid-state laser or that generated directly from the laser diodes is emitted.

20. A method according to Claim 19, wherein

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a) the optical jamming system is constructed so that the laser, directional

constructed so that the laser, directional optics and tracker at the same time or alternately form a laser doppler radar system, which measures the velocity of the missile, and

5

b) the signals of the doppler radar system are passed to the successful combat sensor.

10 21. A method according to Claim 19 or 20, wherein

a) the optical jamming system is constructed so that the laser, directional optics and tracker at the same time form a laser range-finder, which measures the distance of the missile, and

15

b) the signals of the laser range-finder are passed to the successful combat sensor.

20

22. A method according to Claim 21, wherein

with an ejector for optical decoys;

b) on determination of the flight path of the attacking missile established by the missile proximity sensor, tracker and successful combat sensor, the control computer selects and optimises the use of the optical jamming system, decoys and intercept rockets.

10

23. A method according to Claim 21 or 22, wherein the missile proximity sensor is a sensor sensitive in the UV wavelength range.

15

24. A method of operating a missile self defence system substantially as any one herein described with reference to the accompanying drawings.



Application No: GB 9525322.5  
Claims searched: 1 to 24

Examiner: Trevor Berry  
Date of search: 14 February 1996

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK CI (Ed.O): F3C (CAH, CAJ, CFA, CGF)  
Int CI (Ed.6): F41F, F41G, F41H  
Other:

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|----------|---|--------------------|
|          | None.                                     |                    |

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